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ADCOM SECURE VOICE UPGRADE.(U)

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TECHNICAL REPORT

ADCOM SECURE VOICE UPGRADE



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SUMMARY

This report is the result of a request for technical assistance from HQ SAC/DC, concerning the ADCOM Dedicated Secure Voice Upgrade. The report contains alternatives and recommendations for satisfying the requirement. This report is a combined effort of HQ AFCC/EP/XO/LG and the 1842 EEG.

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1.0 INTRODUCTION.

1.1 Program History. As a result of a previous 1842 EEG Technical Report (1842EEG/EETS TR 78-8), a decision was made to use VINSON secure voice equipment to replace the KY-585 vocoders presently being used in the ADCOM system. Replacement of the KY-585 vocoders and the switching/conferencing equipment is considered an essential part of the system upgrade because of poor voice quality and difficulty with logistics support. The ancillary equipment necessary to operate the VINSON is being developed and processed under another program. This program has experienced delays and in its present configuration, will not have a conferencing capability. The conferencing capability is one of the ADCOM system requirements. In light of these developments SAC/DC has asked AFCC to participate in a re-evaluation of methods of satisfying the mission requirements.

1.2 Present Configuration. The present configuration of the ADCOM system is shown in Figure 1. The network is a basic star configuration with switching, conferencing, and control being done at the central site. The equipment at the central site consists of a TD-1094/GSQ Frame Format Converter, a TD-1095/GSQ Digital Combiner, a C-9318/GSQ Secure Voice Switch, KY-585 vocoders, KG-13 cryptographic gear with CAU's, modems, plus timing and power distribution equipment. The equipment at the subscriber sites consist of a modem, KG-13 with CAU, KY-585 vocoders, and timing equipment.

1.3 Operating Procedures. The present system uses manual operator control for connecting subscriber-to-subscriber calls, or to provide subscriber conference connections. A subscriber calls the operator at the central site and requests to be connected to another subscriber or to place a conference call and identifies the subscribers to participate in the conference. The operator then places these calls manually using the Secure Voice Switch and the Digital Combiner, if a conference call is required.

1.4 Operational Requirements. The following features, in order of importance, are required to satisfy the ADCOM secure voice operational requirements with an ROD of 31 Dec 81.

- a. The system must be logistically supportable (commercial or government sources).
- b. Intelligibility must be better than that obtained with the current KY-585 vocoder.
- c. Call completion must be immediate (10 to 15 seconds).
- d. Must have the capability to conference up to 6 subscribers.
- e. If a common user transmission system is used, the call precedence must be consistent with the call completion time requirements.
- f. The number of subscribers on the system must be expandable.
- g. Each subscriber shall have access to any other subscriber.
- h. The terminal equipment to be installed at one of the subscriber sites must not occupy more space than one standard equipment rack 75 inches high.
- i. An automatic switch is preferred over the current manual operation.

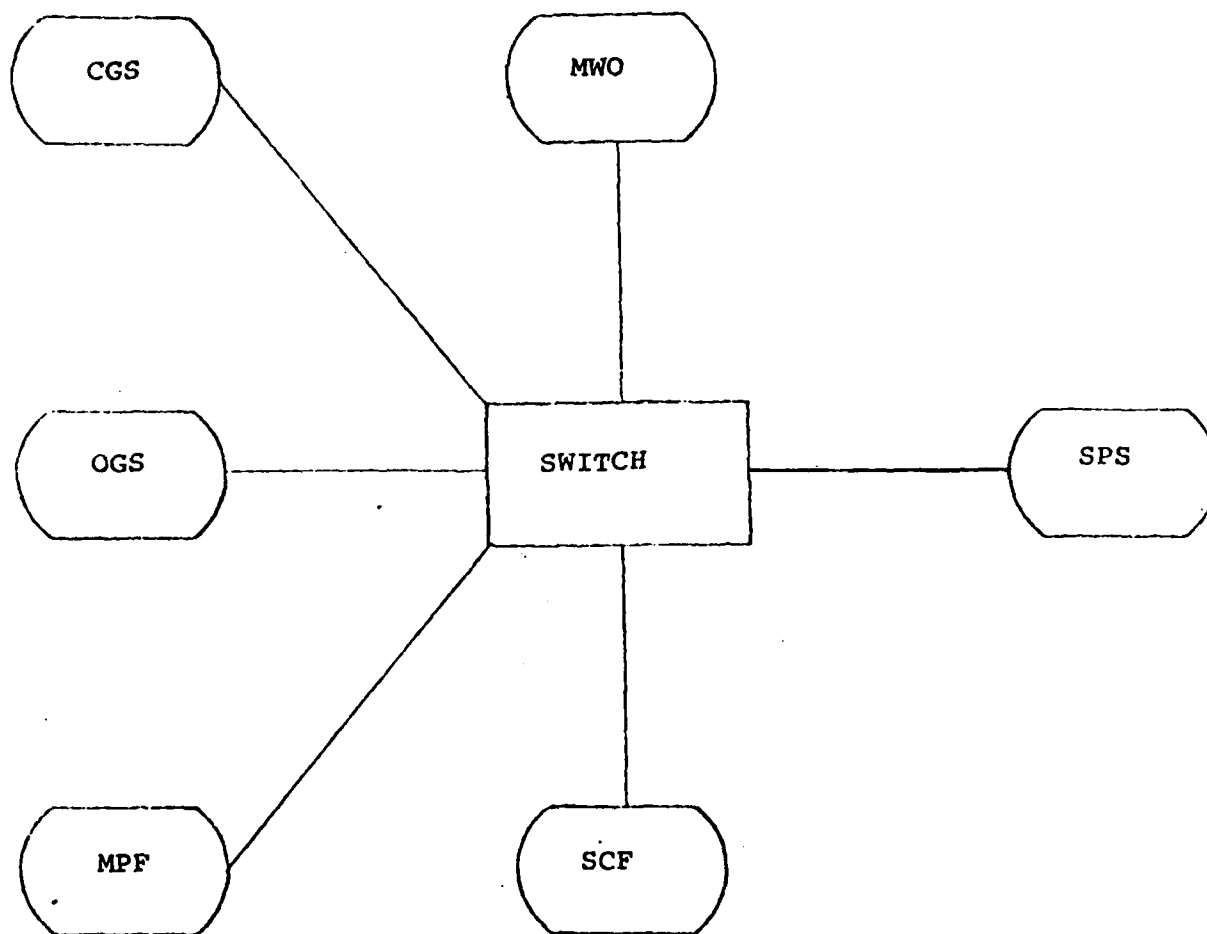


Figure 1. ADCOM Dedicated Secure Voice Network

2.0 EQUIPMENT ALTERNATIVES.

2.1 Vocoder/Cryptographic Equipment. The first step in upgrading the present system is replacing the KY-585 vocoders. This section of the technical report will identify the candidate equipment and evaluate each one in terms of its capability to upgrade the system.

2.1.1 HY-2, CV-3333 Vocoders. Both of these vocoders are interoperable with the KY-585 vocoder and should by design achieve the same intelligibility. The HY-2 vocoder extracts pitch, spectrum, and amplitude information from the voice signal by multiple filtering and quantizing the signal. The signal is then digitally encoded for input to the cryptographic equipment. The Diagnostic Rhyme Test (DRT) score (a measure of speech intelligibility) for the HY-2 is approximately 85%. A DRT score of 100% would represent perfect speech reproduction. Because the analog filtering and quantizing circuits used in the HY-2 require extensive and detailed alignment, which must be identical on both ends of the circuit, they seldom perform at their optimum level. DRT scores in the low 80's or below are normally experienced on operational circuits only a short time after complete alignment of the equipment has been accomplished. The CV-3333 vocoder uses a digital technique to extract pitch, spectrum, and amplitude information from the voice signal. Because no analog filtering and quantizing is involved, the CV-3333 vocoder normally performs at its optimum level and does not suffer from the alignment problems experienced with the HY-2 vocoder. The DRT score for the CV-3333 vocoder is approximately the same as the HY-2 vocoder (85%). Both the HY-2 and the CV-3333 vocoder have full-duplex capability and are compatible with the existing transmission system equipment and the central site switching/conferencing equipment. In essence, either of these vocoders could be used as a direct replacement for the current KY-585 vocoders without changing anything else in the system. The use of the HY-2 vocoder as a replacement for the KY-585 vocoder would not offer any improvement in systems voice quality and the use of the CV-3333 vocoder would only offer a slight improvement in system voice quality. Because of these factors, this alternative will not be considered further.

2.1.2 HY-11 Vocoder. The HY-11 vocoder, used in the AUTOSEVOCOM system, has a DRT score of approximately 75% and would provide no improvement in system voice quality at all. The HY-11 vocoder would not be compatible with the present transmission system, because it operates at a digital bit rate of 9.6 kb/s, nor is it compatible with the central site switching/conferencing equipment. Because of these factors, this alternative will not be considered further.

2.1.3 Vinson Subscriber Terminal (VST). The VST is a full duplex secure voice terminal consisting of a 16 kb/s modem, control units, and two KY-58 Vinson secure voice equipments. The KY-58 contains a Continuous Variable Slope Delta (CVSD) speech processor and key generator in one unit and has DRT scores in the low 90% range over different types of transmission media. The VST would offer a substantial improvement in system voice quality over the existing KY-585. The only transmission media required for the VST is a voice channel, since it contains its own cryptographic function and modem. The current system cryptographic equipment, CAU's, modems, and timing equipment would not be required for operation of the VST. The VST is being developed and produced under an Air Force contract by the Harris Corp. The current contract calls for production of several hundred VST's with the first five being produced in Jan 1982 and the next 15 being produced in Mar 1982. Air Force logistics support for the VST will not be available under this contract until Sept 1982. In order to use the VST as a replacement for the KY-585 vocoder, an interim logistics support plan would have to be worked out with the contractor to cover the period between the time when the equipment first becomes

available (Mar 1982) and the time when full Air Force logistics support can be provided (Sept 82). The VST is not compatible with the present central site switching/conferencing equipment. Possible solutions to this problem will be discussed in further detail in section 2.3 on switching/conferencing.

2.1.4 TSP-200 Vocoder. The TSP Model 200 vocoder is a commercial, tempest tested, microprocessor based voice digitizer. It uses the Linear Predictive Coding (LPC-10) speech algorithm for the conversion of speech to a digital signal. The TSP-200 vocoder is full-duplex and operates at a data rate of 2.4 kb/s. DRT scores for the TSP-200 are in the low 90% range (comparable with the VST) and would offer a substantial improvement in system voice quality over the existing KY-585 vocoders. The TSP-200 is covered under GSA contract at a unit cost of approximately \$15K. Delivery times of 90 days, for less than 12 units, are claimed by the manufacturer. Air Force logistics support does not exist for this unit, so total logistics support would have to be procured from the manufacturer. The TSP-200 is compatible with the existing transmission system equipment (cryptographic equipment, CAU's, modems, and timing equipment) but is not compatible with the existing central site switching/conferencing equipment. Possible solutions to this problem will be discussed in further detail in section 2.3 on switching/conferencing.

2.1.5 MARK IV Vocoder. The MARK IV vocoder is a commercial, tempest tested, programmable voice digitizer. It can be configured with any or all of four different speech algorithms:

- a. LPC-10, full-duplex at 2.4 kb/s.
- b. Adaptive Predictive Coding (APC-4), full-duplex at 6.4 and 9.6 kb/s.
- c. HY-2 compatible vocoder, full-duplex at 2.4 kb/s.
- d. Adaptive Quantizer, full-duplex at 16 kb/s.

The selection of speech algorithm is a switch function on the MARK IV vocoder. The MARK IV, operating in the LPC-10 mode, has DRT scores in the low 90% range (comparable with the TSP-200 and VST vocoders). This same range of DRT scores would also be expected in the APC-4 or Adaptive Quantizer modes of operation. In the HY-2 compatible mode of operation, the MARK IV will achieve the same DRT score as the CV-3333 vocoder (85% range). The MARK IV is not covered under a GSA contract. Unit cost of the MARK IV is approximately \$15K. Delivery times of approximately 120 days, from receipt of order, are claimed by the manufacturer. Air Force logistics support does not exist for this unit, so total logistics support would have to be procured from the manufacturer. The MARK IV operating in the LPC-10 and HY-2 compatible modes is compatible with the existing transmission system equipment. Only the MARK IV, operating in the HY-2 compatible mode, is compatible with the central site switching/conferencing equipment. Further discussion of switching/conferencing using the MARK IV is contained in section 2.3 on switching/conferencing.

2.1.6 Vocoder Summary. Of the vocoders investigated the VST, TSP-200, and the MARK IV are the only ones which would substantially improve the system voice quality, but each of these alternatives presents problems in terms of switching/conferencing. None of these vocoders can be integrated into the system in time to meet the ROD of 31 Dec 1981 and also meet the switching/conferencing requirements.

2.2 Transmission Media. This section of the report will identify different configurations of transmission media and evaluate each one in terms of its capability to meet the system requirements.

2.2.1 AUTOVON. The current AUTOVON system provides precedence/preemption capability which might meet the call completion requirement, but does not provide a secure conferencing capability. AUTOVON is a common user system, not under direct control of the user. This could be a disadvantage in that the availability of the system can only be ascertained after you try to access it. Because of these factors, this alternative will not be considered further.

2.2.2 AUTOSEVOCOM. The current AUTOSEVOCOM system provides secure voice communications through the use of KY-3 (Wide-band, 50 kb/s) secure voice equipment and HY-2 and HY-11 vocoders with the appropriate cryptographic equipment. AUTOSEVOCOM does have a conferencing capability, but when used in conjunction with the HY-2 or HY-11 vocoders would not provide any increase in voice quality over the present system. All of the AUTOSEVOCOM KY-3 assets are currently in use and are not available for use in the ADCOM system. Because of these factors, this alternative will not be considered further.

2.2.3 Dedicated System. A dedicated communications system can be configured to meet all of the system requirements. The use of leased circuits will provide flexibility for future requirements and complete control of the system by the user.

2.2.4 Transmission Media Summary. Recommend the use of a dedicated transmission media (leased circuits) to satisfy the ADCOM requirement.

2.3 Switching/Conferencing. As stated in section 2.1.6, none of the acceptable vocoders (VST, TSP-200 and the MARK IV) can be integrated into the system, satisfy the switching/conferencing requirements, and meet the ROD of 31 Dec 1981. Each vocoder presents different problems in terms of switching/conferencing. This section of the technical report will identify two different switching/conferencing alternatives and evaluate each one in terms of its capability to upgrade the system. The first is the use of the FTC-52 AUTOSEVOCOM Digital Conferencing Unit (DCU), manufactured by Magnavox. The second method is an analog bridge concept using the VST vocoder. The current switching/conferencing equipment is only compatible with the HY-2, CV-3333, KY-585, and the MARK IV in the HY-2 compatible mode.

2.3.1 FTC-52 DCU. The DCU is a conferencing unit capable of serving 10 subscribers. The DCU performs conferencing through the utilization of a Broadcast/Interrupt concept and is capable of conferencing the HY-2, CV-3333, KY-585, TSP-200; or MARK IV vocoders. The DCU cannot conference a mixture of these types of terminal devices, only one type can be conferenced at any one time. The choice of which type of terminal device is to be switched or conferenced is a switch selectable function on the DCU. Both the switching and conferencing functions are controlled manually. The DCU is capable of switching one subscriber to subscriber circuit or conferencing subscribers, but not both simultaneously. The number of subscribers can be increased by adding another DCU to an existing one. DCU's are currently being procured to provide secure voice conferencing in the AUTOSEVOCOM network. Full Air Force logistics support will be available in July, 1982. Current delivery times are approximately 12 months, at a unit cost of approximately \$50K. The DCU is currently not compatible with the VST, but this problem is being discussed as a follow-on contract for the next VST procurement. Time tables for this effort are unknown at this time.

2.3.2 VST's with Analog Bridge. The analog bridge concept is a method of conferencing circuits, in the black, that operate in the half-duplex mode. Although the VST has full-duplex capability it can operate in the half-duplex mode. Under this concept, an analog bridge would be placed at the central site and subscribers to be conferenced would

be switched onto the bridge. Information that is transmitted into the bridge by one subscriber is transmitted out of the bridge to all the subscribers connected to it. The bridge concept presents some operational problems because it is a half-duplex system. Only one subscriber can talk at a time and if another subscriber breaks in on a transmission, the transmission is garbled and lost. The use of this alternative would require the design and development of a new manual switching system. Bridging secure circuits in the red is not feasible because of the degraded voice quality that results from tandeming two secure voice circuits.

3.0 SYSTEM ALTERNATIVES. Because the choice of vocoders has an impact on the switching/conferencing equipment, this section of the technical report will present the vocoders, identified in section 2.1 as being able to substantially improve the system voice quality (VST, TSP-200, and MARK IV in the LPC-10 mode), along with the switching/conferencing alternatives for each.

3.1 VST's and Analog Bridge. VST's to satisfy the ADCOM secure voice requirement will be available in Mar 1982. Because the present central site switching/conferencing equipment is not compatible with the VST, a new one would have to be designed and developed. There is some risk associated with this alternative because the analog bridge concept, using VST's, is an untried configuration. There is also risk associated with the design and development of a new switching system in terms of how soon it could be accomplished. In its final configuration this alternative would provide a half-duplex system, creating operational and control problems.

3.2 TSP-200 Vocoder and FTC-52 DCU. TSP-200 vocoders to satisfy the ADCOM secure voice requirement can be available within 90 days of placing the order. Because the present central site switching/conferencing equipment is not compatible with the TSP-200, a new switching system would have to be designed and developed as an interim measure. There is some risk associated with the design and development of a new switching system in terms of how soon it can be accomplished. No conferencing capability could be provided with this alternative until a FTC-52 DCU is procured and integrated into the system. Only after this was accomplished could all the requirements be met.

3.3 MARK IV Vocoder and FTC-52 DCU. If the MARK IV vocoders were procured with the HY-2 and LPC-10 speech algorithms (switch selectable), they could be implemented in the HY-2 mode and be compatible with the present central site switching and conferencing equipment. Some improvement in voice quality, over the present system, could be expected because the MARK IV is state-of-the-art equipment and will not suffer from alignment and aging problems as the KY-585 does. This alternative would provide an initial small improvement in voice quality and would also provide the conferencing capability earlier than the other alternatives. The central site switching/conferencing equipment could be replaced at a later date, with an FTC-52 DCU, and the MARK IV vocoders switched to the LPC-10 mode for improved voice quality.

4.0 RECOMMENDATIONS. Recommend the MARK IV vocoder be used as a replacement for the KY-585 vocoders with the addition of an FTC-52 DCU as a replacement of the central site switching/conferencing equipment. This alternative is recommended because it does not contain the design and development risk the other alternatives have. It does require the continued use of the central site switching/conferencing equipment until it can be replaced with the FTC-52 DCU. While it is known that logistics support of the central site equipment is a problem, its continued use, until it can be replaced, is preferable to the risk associated with the design and development of a new switching system. While none of the alternatives will meet the required ROD, the recommended alternative can be implemented in the same time frame as the other alternatives while satisfying all the requirements.

5.0 CONSIDERATIONS.

5.1 Switch Development. In those alternatives where there is a certain amount of risk, the amount of risk could only be ascertained after the engineering effort has been initiated.

5.2 Equipment Delivery. Delivery times identified for equipment are only estimates. Aggressive procurement action could shorten these times, but contractor delays could lengthen them.

5.3 Automatic Switching. All the alternatives presented here involve manual switching. A follow on project could be undertaken, after the system is upgraded, to automate the switching function.

5.4 FTC-52 DCU Procurement. Since these units are being procured to improve the AUTOSEVOCOM conferencing capability, it is possible that one of these units could be diverted for this program. This action could considerably shorten the implementation time for those alternatives using the FTC-52 DCU.

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